Lecture 12 - Capturing Surplus

ECON 3070 - Intermediate Microeconomic Theory

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Overview

In this chapter, we will discuss ways that firms can capture additional surplus.

- What information a firm needs to capture additional surplus
- What market characteristics are necessary to enable firms
- We will discuss price discrimination, bundling, and versioning

Price Discrimination

The act of charging different price to different consumers for the same good or service is known as **price discrimination**

- The goal is for the firm to increase their producer surplus.

Three Types of Price Discrimination

1. **First-degree price discrimination** - firms prices each unit of the good to the consumer's maximum WTP.
   → Example: auction - seller hopes to find the consumer with the highest WTP for the good.
2. **Second-degree price discrimination** - Firm offers customers quantity discounts.
   → Example: a grocery store offer to buy one and get the 2nd one at half price.
3. **Third-degree price discrimination** - Firm divides market into segments, and sets price for each segment by equating MR to MC for each group.
   → Example: movie ticket prices for students vs. adults.

Price Discrimination

There are three necessary market features for price discrimination:

1. Market power - demand curve is downward sloping
2. Information on consumer WTP
3. No opportunity for resale or arbitrage

Try It Yourself

The conditions for capturing more surplus through price discrimination **do not** include

A) an ability to determine which groups of people have the greatest wealth.

B) an ability to differentiate different market segments meaning that some groups of people are willing to pay more for a product than others.

C) an ability to prevent resale of products.

D) an imperfectly competitive industry.

First-Degree Price Discrimination

Remember that we can think of a market demand curve as the willingness to pay curve:

- Consumers are lined up from highest WTP to lowest
- With first-degree price discrimination, firm is able to charge each customer their WTP (they need to be really smart to do this!!)

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In this case, the firm will keep selling the good as long as the consumer's WTP is greater than their marginal cost.

- This is because the marginal revenue curve under first-degree price discrimination is the demand curve!

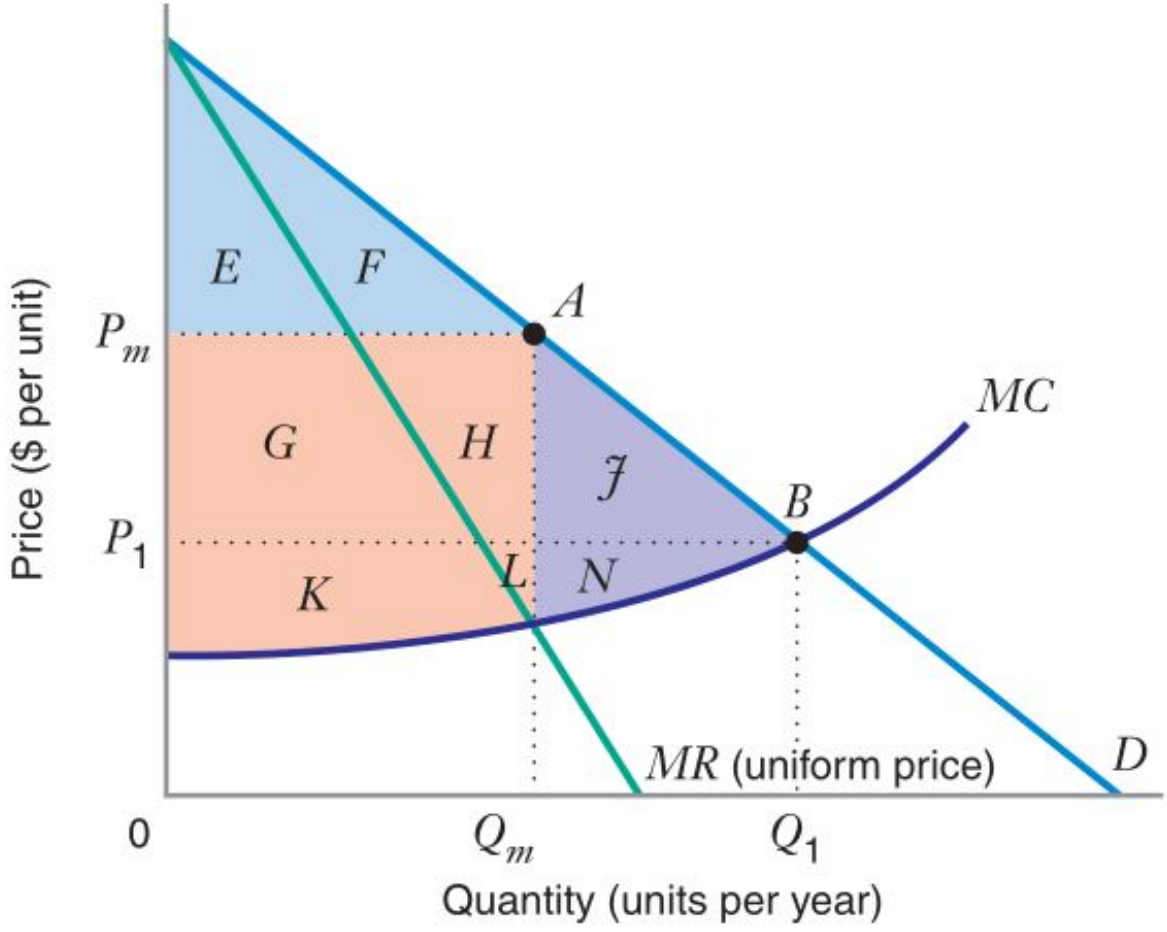
First-Degree Price Discrimination

What happens to surplus in this case:

1. Because each consumer pay's their WTP, they receive no consumer surplus.
2. Producer surplus is the area above their MC curve and below the demand curve. In short, the firm captures all of the surplus.
3. And because they can charge different prices, they sell the socially-optimal quantity. There is no deadweight loss.

First-Degree Price Discrimination

With first-degree PD, the firm captures the total surplus in the market, and there is no deadweight loss.



First-Degree Price Discrimination

Would this work with a pair of designer sunglasses?

- Suppose the firm knew exactly how much each person that came into the store was willing to pay.
- And suppose that they charged every consumer their WTP.

First-Degree Price Discrimination

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Someone with a high WTP might instead just wait for someone with a low WTP to buy a pair and then offer them more than they paid

This illustrates why it can't be possible to resell the item. Otherwise, nobody would be willing to pay a higher price than anyone else.

Try It Yourself

Suppose a firm has constant marginal cost $MC = 2$, and faces a market demand curve of $P = 20 - Q$. What will be a single-price monopolist's producer surplus in the market?

Try It Yourself

Suppose a firm has constant marginal cost $MC = 2$, and faces a market demand curve of $P = 20 - Q$. Suppose that the firm can now perfectly price discriminate. What will be the firm's producer surplus?

First-Degree Price Discrimination

Higher education is a market where firms engage in first-degree PD. Even though universities are not monopolists, they still face a downward-sloping demand curve.

Question: How do colleges estimate your WTP?

First-Degree Price Discrimination

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Question: How do colleges estimate your WTP?

- The price you pay depends on your expected family contribution (EFC) from FAFSA.
- Those with a higher ability to pay receive less money in need-based aid.

Second-Degree Price Discrimination

For many goods and services, consumers often buy more than one unit.

- And their individual demand curves are often downward sloping.
- In other words, their WTP decreases as they buy more.
- Sellers can capture additional surplus by charging customers a lower price for the second unit than the first.

This is **second-degree price discrimination**

Second-Degree Price Discrimination

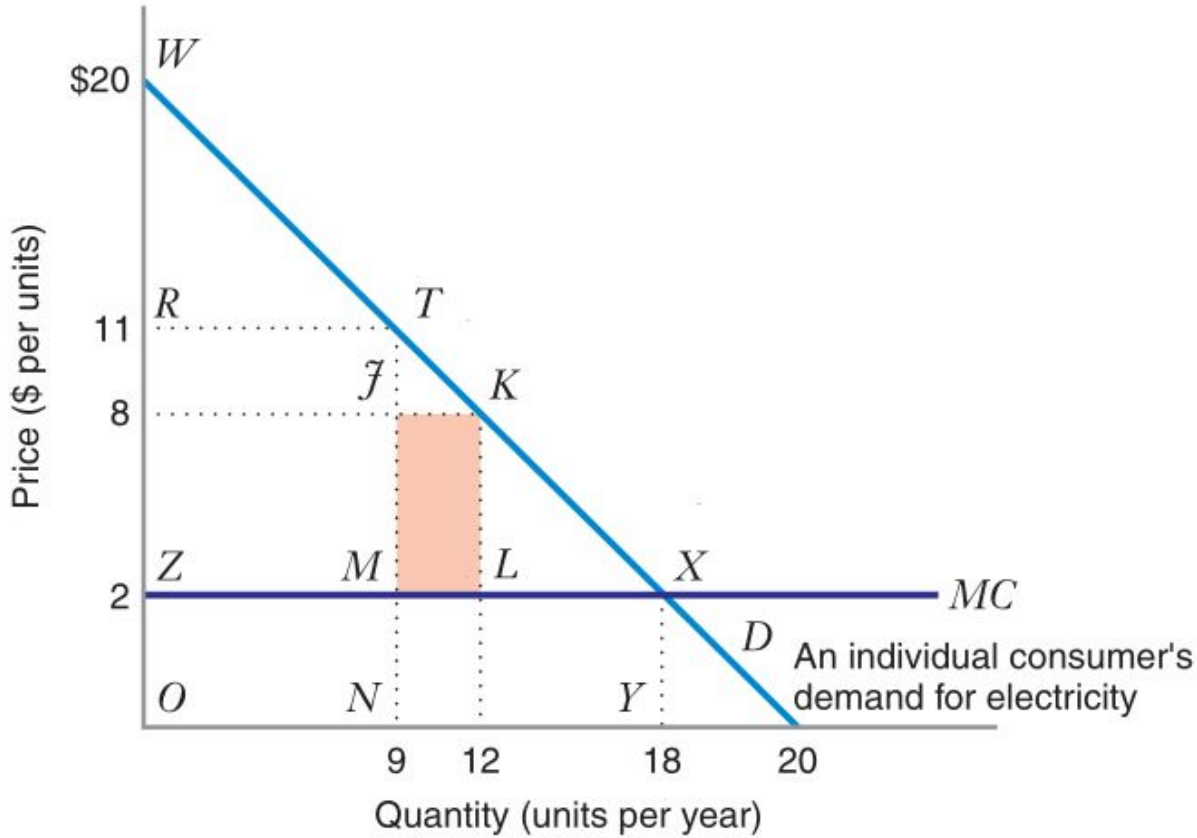
The first form of second-degree PD is block pricing.

For example, suppose there is only one consumer in the market for electricity.

- The electric company charges $11 per unit for the first 9 megawatt-hour used and $8 for every Mwh after that.
- The consumer is will buy more than if every unit simply cost $11, but the additional revenue can still be extracted for the first 9 units.
- This type of pricing is known as a **block tariff**.

Second-Degree Price Discrimination

The firm captures additional producer surplus by selling additional units at a lower price.

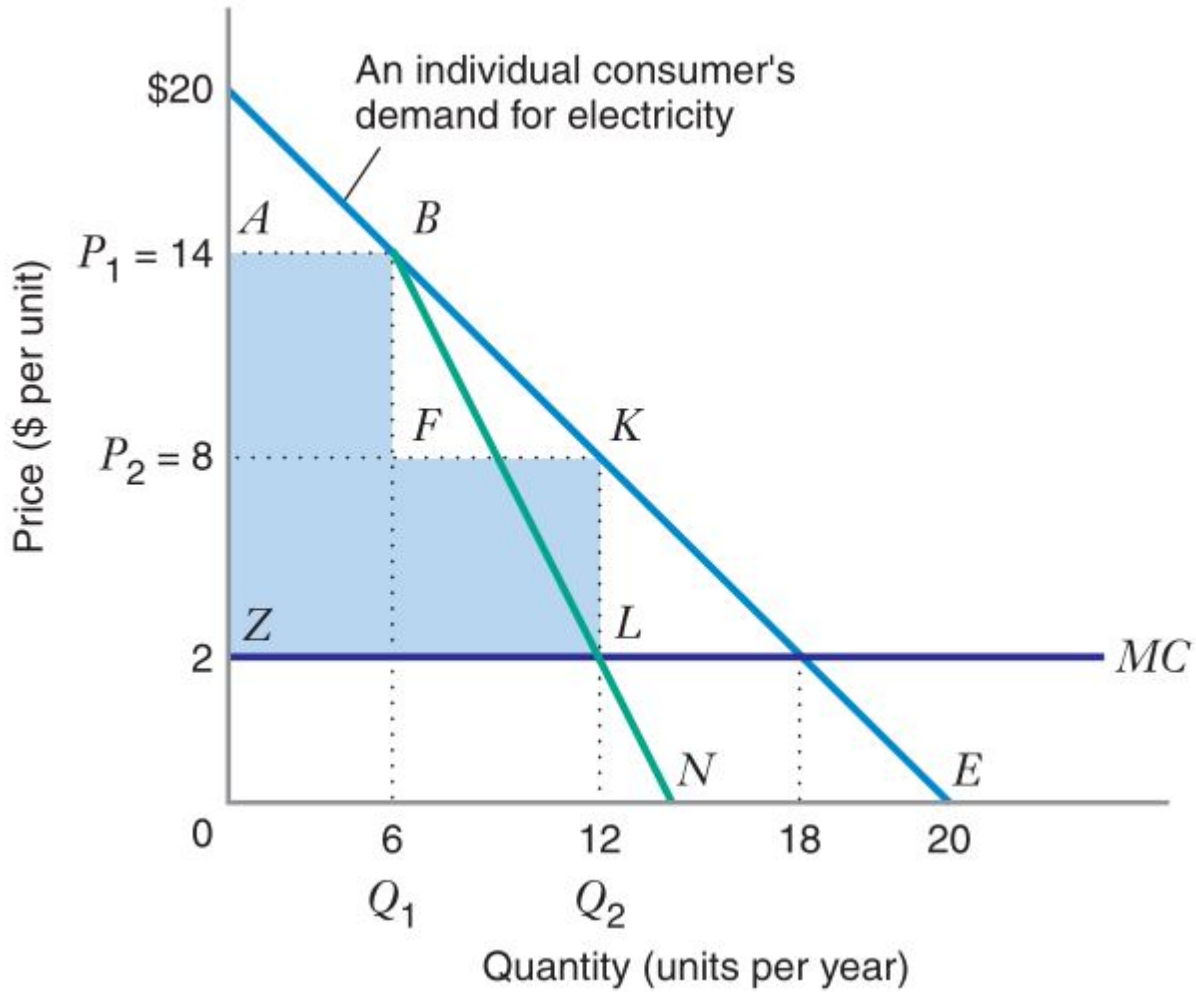


Second-Degree Price Discrimination

How do we find the optimal price and quantity for the first and second blocks?

1. Write producer surplus (or profit) in terms of Q_1 and Q_2.
2. Maximize the profit function with respect to both Q_1 and Q_2. Find two equations.
3. Solve the system of two equations for Q_1 and Q_2

Second-Degree Price Discrimination



Second-Degree Price Discrimination

Example: Suppose demand is given by $P = 20 - Q$, and the firm's total cost is given by $TC(Q) = 2Q$, such that $MC(Q) = 2$.

The firm's profit function is given by

$$\Pi = P_1 Q_1 + P_2(Q_2 - Q_1) - 2 * Q_2$$

If we plug the demand function in for P_1 and P_2, we find

$$\Pi = \underbrace{(20 - Q_1)}_{P_1 = P(Q_1)} Q_1 + \underbrace{(20 - Q_2)}_{P_2 = P(Q_2)}(Q_2 - Q_1) - 2 * Q_2$$

Second-Degree Price Discrimination

We are solving an unconstrained maximization problem, so we simply take derivatives w.r.t. Q_1 and Q_2 and set equal to zero:

$$\frac{\partial}{\partial Q_1} = (20 - 2Q_1) - 20 + Q_2 = 0$$
$$\frac{\partial}{\partial Q_2} = 20 - 2Q_2 + Q_1 - 2 = 0$$

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$$\frac{\partial}{\partial Q_2} = 20 - 2Q_2 + Q_1 - 2 = 0$$

Simplifying the first equation, we have $Q_2 = 2Q_1$. Plugging that into the second equation:

$$20 - 4Q_1 + Q_1 - 2 = 0 \implies Q_1^* = 6$$

Second-Degree Price Discrimination

Plugging $Q_1^* = 6$ into the simplified first equation:

$$Q_2^* = 12$$

Prices are found by plugging each quantity into the demand function:

$$P_1^* = 20 - Q_1^* = 14 \qquad \text{and} \qquad P_2^* = 20 - Q_2^* = 8$$

Second-Degree Price Discrimination

The second type of second-degree price discrimination is a two-part tariff.

- We discussed this from the consumer's perspective in chapter 5.

A **two-part tariff** is when the firm charges a subscription fee, and then a per-unt price.

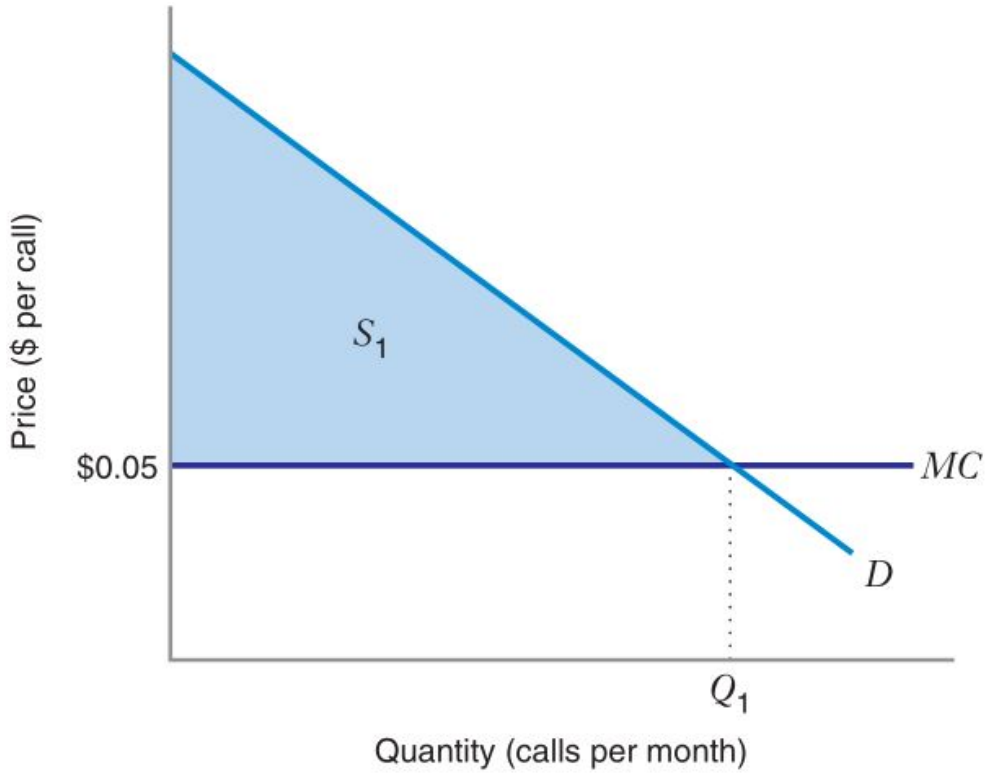
- Examples: Costco, Amazon Prime, Zipcar.

Second-Degree Price Discrimination

For example, suppose that a telephone company has a per-unit cost of $0.05.

- If the provider sets the per-unit price to $0.05, there will be no deadweight loss
- Then the firm can set the subscription cost to whatever price is needed to capture all of the surplus (e.g. $20).

Second-Degree Price Discrimination



Second-Degree Price Discrimination

More generally, the firm should set the per-unit price such that $D = MC$ (as opposed to $MR = MC$).

- That's because with the subscription fee, they don't have to give up producer surplus on previous units.
- They just capture it back with the subscription fee.
- The subscription fee can be set as high as consumer surplus, and the consumer will be indifferent.

Second-Degree Price Discrimination

If there is a lot of heterogeneity in demand curves, then a firm can offer a menu of subscription packages.

- Think of a ski resort, or a cell phone service provider.

Then the customers “sort” themselves according to their demand.

- The firm can extract more surplus from each group.

Third-Degree Price Discrimination

Third-degree price discrimination means charging different prices to different groups of customers based on some observable characteristic. For example,

- Student prices at a movie theater
- Coupons and rebates
- Video game prices declining over time

These allow the firm to charge higher prices to those with higher average willingness to pay.

Third-Degree Price Discrimination

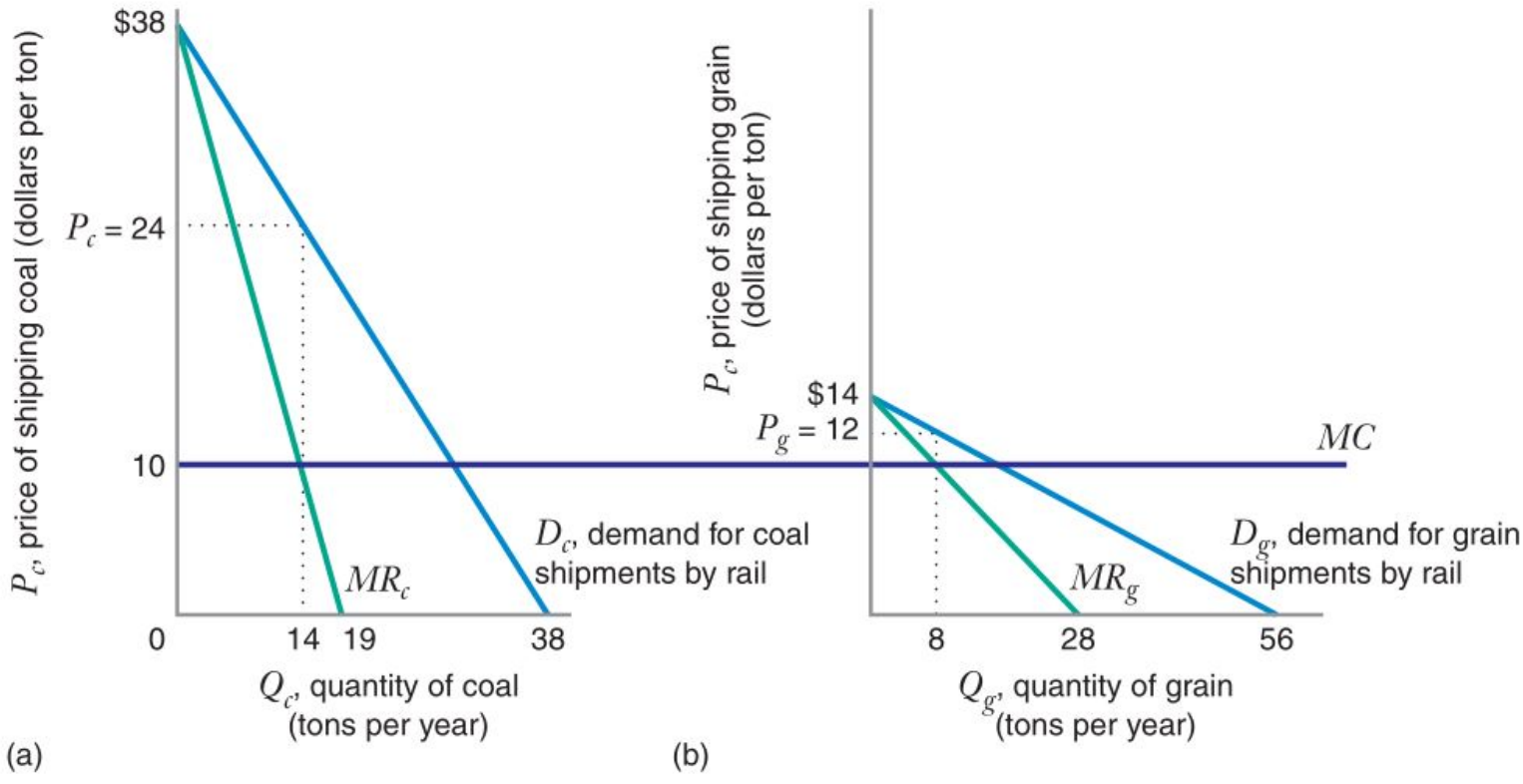
Consider rail transportation in the early 20th century:

- It cost the railroad about the same amount of money to transport coal and grain.
- But railroads faced more competition from barges and trucks when carrying grain (available substitutes)
- Thus, the railroad would charge 2-3 times the price to ship coal even though MC was the same

Again, market power matters!

Third-Degree Price Discrimination

The market demand for rail shipping is flatter for grain since there are better substitutes



Third-Degree Price Discrimination

How does a firm decide the profit maximizing prices to charge?

- If MC is constant, firm just sets $MR(Q^*) = MC(Q^*)$ in each market (or for each group), and then finds P such that $D(P) = Q^*$ (just like single-price monopolist).

Third-Degree Price Discrimination

How does a firm decide the profit maximizing prices to charge?

- If MC is constant, firm just sets $MR(Q^*) = MC(Q^*)$ in each market (or for each group), and then finds P such that $D(P) = Q^*$ (just like single-price monopolist).

If MC isn't constant, firm has to take into account that selling another unit in market A increases the cost in market B. Firm's problem is:

$$\max_{Q_A, Q_B} P_A Q_A + P_B Q_B + TC(Q_A + Q_B)$$

Third-Degree Price Discrimination

Example: Suppose a railroad faces demand curves for transporting grain and coal given by $P_C = 38 - Q_C$ and $P_G = 14 - \frac{1}{4}Q_G$. Marginal cost is given by $MC = 10$.

For grain, the firm sets $MR(Q_G^*) = MC(Q_G^*)$. $MR(Q_G^*)$ is given by

$$\frac{\partial[P(Q_G)Q_G]}{\partial Q_G} = \frac{\partial[14Q_G - \frac{1}{4}Q_G^2]}{\partial Q_G} = 14 - \frac{1}{2}Q_G$$

Third-Degree Price Discrimination

The optimal quantity of grain is given by:

$$14 - \frac{1}{2}Q_G = 10 \implies Q_G^* = 8.$$

Market price is

$$P_G^* = 14 - \frac{1}{4} * 8 = 12$$

Third-Degree Price Discrimination

For coal, the firm sets $MR(Q_C^*) = MC(Q_C^*)$. $MR(Q_C^*)$ is given by

$$\frac{\partial[P(Q_C)Q_C]}{\partial Q_C} = \frac{\partial[38Q_C - Q_C^2]}{\partial Q_C} = 38 - 2Q_C$$

The optimal quantity of coal is given by:

$$38 - 2Q_C = 10 \implies Q_C^* = 14$$

Market price is

$$P_C^* = 38 - 14 = 24$$

Try It Yourself

Which of the following statements regarding a monopoly's first-degree price discrimination is correct?

A) With first-degree price discrimination, consumer surplus is small, yet still greater than zero.

B) With first-degree price discrimination, producer surplus is lower than with uniform pricing.

C) With first-degree price discrimination, deadweight loss is large.

D) With first-degree price discrimination, total surplus is greater than when the monopoly charges a uniform price.

Screening

Since it's so hard to know consumers' WTP, firms sometimes use observable characteristics to sort people into groups with high or low expected WTP.

This is known as **screening**.

- For example, movie theaters figure that, on average, students have lower WTP.
- They can screen customers based on whether they are a student or not.

Intertemporal Price Discrimination

Intertemporal price discrimination is when a firm sells a good at different prices at different times of the day (or week, or year) to capture additional surplus.

- For example, movies and video games often sell at higher prices initially, and then the price falls over time.
- Airline tickets may be cheaper 3 months out, and very expensive one week out.

Note that prices declining over time does not always reflect price discrimination:

- Sometimes it's a result of decreasing marginal costs (think of flat-screen TVs)
- Sometimes it's a result of increasing competition in the market

Coupons and Rebates

Firms use coupons and rebates to price discriminate.

- People who are more price sensitive (lower WTP) are more likely to clip coupons
- They pay a lower net price as a result.
- Those who are less price sensitive may not bother with coupons.

Capacity Constraints

Some firms are constrained in the number of units of a good they can sell of a given product.

- Examples: Airlines, movie theaters, cruise lines.

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In that case, the firm may not be able to set Q_1 and Q_2 such that $MR(Q_1) = MC(Q)$ and $MR(Q_2) = MC(Q)$ where $Q = Q_1 + Q_2$.

Instead, suppose that $MR(Q_1) = MC(Q)$ but $MR(Q_2) > MC(Q)$ for two segments of some market.

- This implies $MR_2 > MR_1$

Capacity Constraints

If $MR_2 > MR_1$, what should the firm do?

- Since MC is the same for both market segments, we can focus only on MR.

Recall that marginal revenue is the additional revenue from selling one more unit.

- Then if the firm sells one less unit in market 1 and one more unit market 2, total revenue will go up.
- Alternatively, if $MR_1 > MR_2$, the firm should sell more to market 1 and less to market 2.

Capacity Constraints

Therefore, the optimal allocation to segments 1 and 2 is such that $MR_1 = MR_2$.

- Because of the capacity constraint, the firm can't produce enough to where $MR = MC$ for either segment.

The result is that the firm must solve a system of two equations: $MR_1 = MR_2$ and $Q_1 + Q_2 = C$, where C is the firm's capacity.

Capacity Constraints

Do firms actually think about their problem in this way? Might seem somewhat unrealistic, but firms face this decision all the time

- Airlines have to decide where to set their prices so that they can sell some seats at a low price, and some at a higher price.
- Movie theaters have to decide how to set student and general admission prices to maximize profit.

Capacity Constraints

Suppose that a firm sells their good in two different markets, 1 and 2, and faces demand functions $Q_1 = 200 - 2P_1$ and $Q_2 = 250 - P_2$. Marginal cost is \$10 per unit, and the firm's capacity is 150 units. What is the optimal price and quantity in each market?

Capacity Constraints

Suppose that a firm sells their good in two different markets, 1 and 2, and faces demand functions $Q_1 = 200 - 2P_1$ and $Q_2 = 250 - P_2$. Marginal cost is \$10 per unit, and the firm's capacity is 150 units. What is the optimal price and quantity in each market?

The firm should set Q_1 and Q_2 such that $MR(Q_1) = MR(Q_2)$. Therefore, we need to find the marginal revenue curves for both segments.

First, write the demand functions such that P is a function of Q.

$$P_1 = 100 - \frac{1}{2}Q_1 \qquad \text{and} \qquad P_2 = 250 - Q_2$$

Capacity Constraints

Next, find MR_1 and MR_2:

$$TR(Q_1) = P_1 * Q_1 = 100Q_1 - (1/2)Q_1^2 \implies MR(Q_1) = 100 - Q_1$$
$$TR(Q_2) = P_2 * Q_2 = 250Q_2 - Q_2^2 \implies MR(Q_2) = 250 - 2Q_2$$

Finally, equate MR_1 to MR_2, gives us $100 - Q_1 = 250 - 2Q_2$. Our capacity constraint is given by $Q_1 + Q_2 = 150$

Capacity Constraints

Finally, we can solve this system of two equations. First, plug the second equation into the first:

$$100 - (150 - Q_2) = 250 - 2Q_2 \implies Q_2^* = 100$$

Then

$$Q_1^* = 150 - Q_2^* = 150 - 100 = 50$$

Finally, we can find prices using the segment demand functions:

$$P_1^* = 100 - \frac{1}{2}50 = 75 \qquad \text{and} \qquad P_2^* = 250 - 100 = 150$$

Try It Yourself

Let a monopolist face consumer group A with inverse demand $P_A = 100 - 2Q_A$ and consumer group B with inverse demand $P_B = 80 - Q_B$. The monopolist can conduct third degree price discrimination, but faces a capacity constraint that $Q_A + Q_B \leq 50$. What will be the amount supplied to each of the customer groups?

Versioning

Another way that firms capture additional surplus is by versioning.

Versioning is the strategy of selling two or more versions of a product with different qualities.

- For example, laptop manufacturers offer low-quality and high-quality versions of their products.
- The hope is that less price-sensitive consumers will be willing to pay a larger markup for the item with additional features, or quality.
- Likewise, the firm hopes that they can attract price sensitive consumers with a lower-quality product, without causing the price-insensitive consumers to switch.

Damaged Goods Strategy

An interesting type of versioning is known as the **damaged goods strategy**.

- A firm deliberately “damages” a product by removing features or adjusting performance and sells that good to the low-WTP consumers.
- Ironically, damaging the product may create an additional cost, so that the damaged good has a higher MC.